SECTION

3.4

DETENTION STRUCTURAL STORMWATER CONTROLS

3.4.1 Dry Detention / Dry ED Basins

Description: A surface storage basin or facility designed to provide water quantity control through detention and/or extended detention of stormwater runoff.

REASONS FOR LIMITED USE

- Controls for stormwater quantity only – not intended to provide water quality treatment

KEY CONSIDERATIONS

- Applicable for drainage areas up to 75 acres
- Typically less costly than stormwater (wet) ponds for equivalent flood storage, as less excavation is required
- Used in conjunction with water quality structural control
- Provides recreational and other open space opportunities between storm runoff events

STORMWATER MANAGEMENT SUITABILITY

- ☐ **Water Quality**
- ☑ **Channel / Flood Protection**

SPECIAL APPLICATIONS

- ☐ **Pretreatment**
- ☐ **High Density / Ultra-Urban**
- ☐ **Other:**

Residential Subdivision Use: *Yes*

3.4.1.1 General Description

Dry detention and dry extended detention (ED) basins are surface facilities intended to provide for the temporary storage of stormwater runoff to reduce downstream water quantity impacts. These facilities temporarily detain stormwater runoff, releasing the flow over a period of time. They are designed to completely drain following a storm event and are normally dry between rain events.

Dry detention basins are intended to provide overbank flood protection (peak flow reduction of the 50-year storm, Q_{p50}) and can be designed to control the extreme flood (100-year, Q_f) storm event. Dry ED basins provide downstream channel protection through extended detention of the channel protection volume (CP_v), and can also provide Q_{p50} and Q_f control.

Both dry detention and dry ED basins provide limited pollutant removal benefits and are not intended for water quality treatment. Detention-only facilities must be used in a treatment train approach with other structural controls that provide treatment of the WQ_v (see Section 3.1).

Compatible multi-objective use of dry detention facilities in strongly encouraged.

3.4.1.2 Design Criteria and Specifications

Location

- Dry detention and dry ED basins are to be located downstream of other structural stormwater controls providing treatment of the water quality volume (WQ_v). See Section 3.1 for more information on the use of multiple structural controls in a treatment train.
- The maximum contributing drainage area to be served by a single dry detention or dry ED basin is 75 acres.

General Design

- Dry detention basins are sized to temporarily store the volume of runoff required to provide overbank flood (Q_{p50}) protection (i.e., reduce the post-development peak flow of the 50-year storm event to the pre-development rate), and control the 100-year storm (Q_f) if required.

  Dry ED basins are sized to provide extended detention of the channel protection volume over 24 hours and can also provide additional storage volume for normal detention (peak flow reduction) of Q_{p50} and Q_f.

  Routing calculations must be used to demonstrate that the storage volume is adequate. See Section 2.2 (*Storage Design*) for procedures on the design of detention storage.

- Storage volumes greater than 100 acre-feet are subject to the requirements of the Georgia Safe Dams Act unless the facility is excavated to this depth.

- Vegetated embankments shall be less than 20 feet in height and shall have side slopes no steeper than (horizontal to vertical) 3:1. Riprap-protected embankments shall be no steeper than 3:1. Geotechnical slope stability analysis is recommended for embankments greater than 10 feet in height and is mandatory for embankment slopes steeper than those given above. All embankments must be designed to State of Georgia guidelines for dam safety. Retaining wall type embankments are not permitted unless approved by Columbia County.

- The maximum depth of the basin should not exceed 10 feet.

- Areas above the normal high water elevations of the detention facility should be sloped toward the basin to allow drainage and to prevent standing water. Careful finish grading is required to avoid creation of upland surface depressions that may retain runoff. The bottom area of storage facilities should be graded toward the outlet to prevent standing water conditions. A low flow or pilot channel across the facility bottom from the inlet to the outlet (often constructed with riprap) is recommended to convey low flows and prevent standing water conditions.

- Adequate maintenance access must be provided for all dry detention and dry ED basins.

Inlet and Outlet Structures

- Inflow channels are to be stabilized with flared riprap aprons, or the equivalent. A sediment forebay sized to 0.1 inches per impervious acre of contributing drainage should be provided for dry detention and dry ED basins that are in a treatment train with off-line water quality treatment structural controls.

- For a dry detention basin, the outlet structure is sized for Q_{p50} control (based upon hydrologic routing calculations) and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure. Small outlets that will be subject to clogging or are difficult to maintain are not acceptable.

  For a dry ED basin, a low flow orifice capable of releasing the channel protection volume over 24 hours must be provided. The channel protection orifice should have a minimum diameter of 3 inches and should be adequately protected from clogging by an acceptable external trash rack. The orifice diameter may be reduced to 1 inch if internal orifice protection is used (e.g., an over-perforated vertical stand pipe with 0.5-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves can also be used to achieve this equivalent diameter.

  See Section 2.3 (Outlet Structures) for more information on the design of outlet works.

- Seepage control or anti-seep collars shall be provided for all outlet pipes.

- Riprap, plunge pools or pads, or other energy dissipators are to be placed at the end of the outlet to prevent scouring and erosion. If the basin discharges to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. See Section 4.5, Energy Dissipation Design, for more guidance.

- An emergency spillway is to be included in the stormwater pond design to safely pass the extreme flood flow. The spillway prevents pond water levels from overtopping the embankment and causing structural damage. The emergency spillway must be designed to State of Georgia guidelines for dam safety and must be located so that downstream structures will not be impacted by spillway discharges. The emergency spillway shall not be located in a fill area.
- A minimum of 1 foot of freeboard must be provided, measured from the top of the water surface elevation for the extreme flood, to the lowest point of the dam embankment not counting the emergency spillway.

3.4.1.3 Inspection and Maintenance Requirements

Activity	Schedule
• Remove debris from basin surface to minimize outlet clogging and improve aesthetics.	Annually and following significant storm events
• Remove sediment buildup. • Repair and revegetate eroded areas. • Perform structural repairs to inlet and outlets.	As needed based on inspection
• Mow to limit unwanted vegetation.	Routine

Table 3.4.1-1 Typical Maintenance Activities for Dry Detention / Dry ED Basins
(Source: Denver Urban Storm Drainage Manual, 1999)

3.4.1.4 Example Schematics

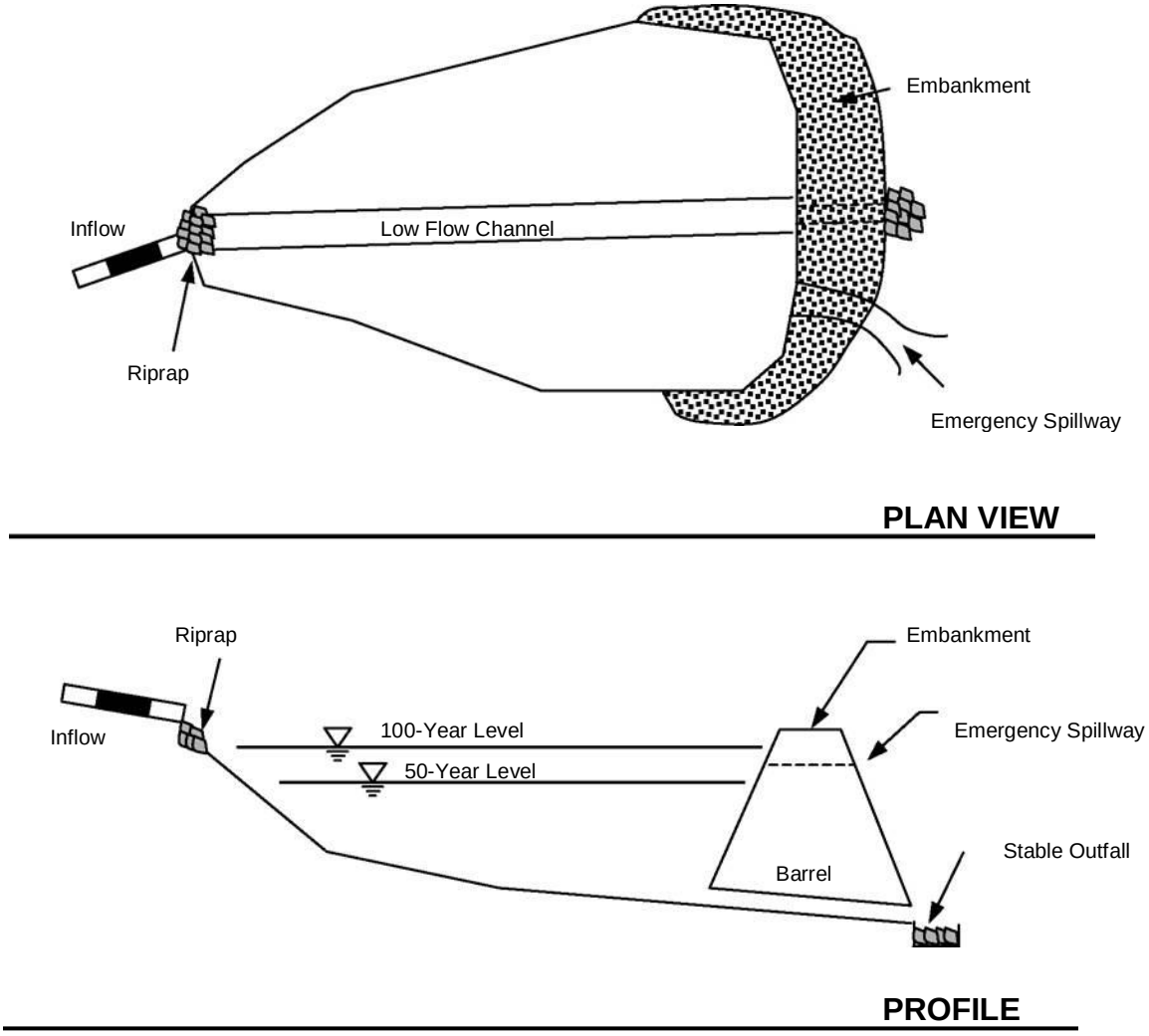

Figure 3.4.1-1 Schematic of Dry Detention Basin

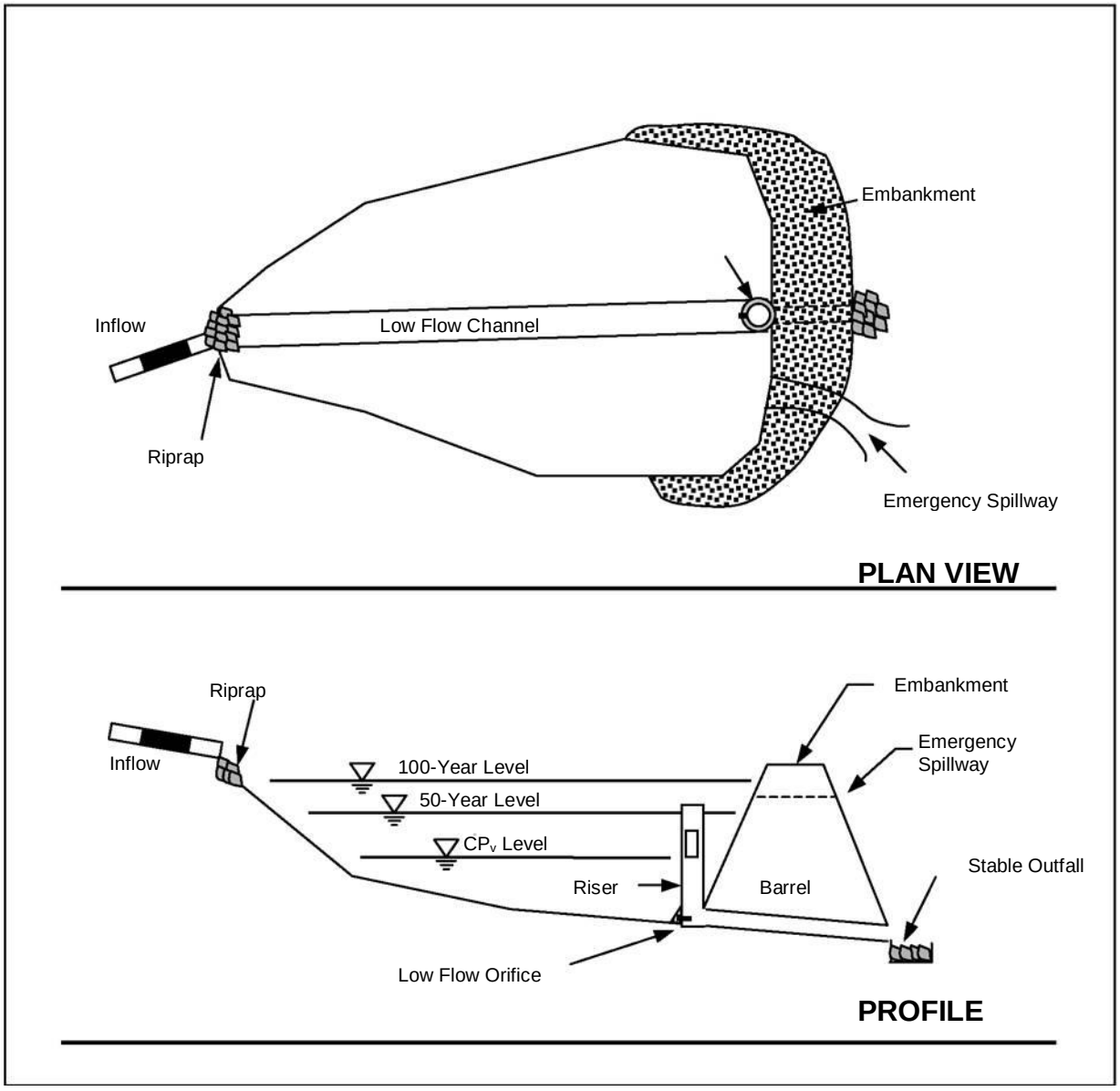

Figure 3.4.1-2 Schematic of Dry Extended Detention Basin

3.4.2 Multi-Purpose Detention Areas

Description: A facility designed primarily for another purpose, such as parking lots and rooftops that can provide water quantity control through detention of stormwater runoff.

REASONS FOR LIMITED USE

- Controls for stormwater quantity only – not intended to provide water quality treatment

KEY CONSIDERATIONS

- Allows for multiple uses of site areas and reduces the need for downstream detention facilities
- Used in conjunction with water quality structural control
- Adequate grading and drainage must be provided to allow full use of facility's primary purposes following a storm event

STORMWATER MANAGEMENT SUITABILITY

- ☐ **Water Quality**
- ☑ **Channel / Flood Protection**

SPECIAL APPLICATIONS

- ☐ **Pretreatment**
- ☑ **High Density / Ultra-Urban**
- ☐ **Other:**

Residential Subdivision Use: *Yes*

3.4.2.1 General Description

Multi-purpose detention areas are site areas primarily used for one or more specific activities that are also designed to provide for the temporary storage of stormwater runoff to reduce downstream water quantity impacts. Example of multi-purpose detention areas include:

- Parking Lots
- Rooftops
- Sports Fields
- Recessed Plazas

Multi-purpose detention areas are normally dry between rain events, and by their very nature must be useable for their primary function the majority of the time. As such, multi-purpose detention areas should not be used for extended detention (CP_v control).

Multi-purpose detention areas are not intended for water quality treatment and must be used in a treatment train approach with other structural controls that provide treatment of the WQ_v (see Section 3.1).

3.4.2.2 Design Criteria and Specifications

Location

- Multi-purpose detention areas can be located upstream or downstream of other structural stormwater controls providing treatment of the water quality volume (WQ_v). See Section 3.1 for more information on the use of multiple structural controls in a treatment train.

General Design

- Multi-purpose detention areas are sized to temporarily store a portion or all of the volume of runoff required to provide overbank flood (Q_{p50}) protection (i.e., reduce the post-development peak flow of the 50-year storm event to the pre-development rate) and control the 100-year storm (Q_f) if required.

  Routing calculations must be used to demonstrate that the storage volume is adequate. See Section 2.2 (*Storage Design*) for procedures on the design of detention storage.

- All multi-purpose detention facilities must be designed to minimize potential safety risks, potential property damage, and inconvenience to the facility's primary purposes. Emergency overflows are to be provided for storm events larger than the design storm. The overflow must not create a significant adverse impact to downstream properties or the conveyance system.

Parking Lot Storage

- Parking lot detention can be implemented in areas where portions of large, paved lots can be temporarily used for runoff storage without significantly interfering with normal vehicle and pedestrian traffic. Parking lot detention can be created in two ways: by using ponding areas along sections of raised curbing, or through depressed areas of pavement at drop inlet locations.
- The maximum depth of detention ponding in a parking lot, except at a flow control structure, should be 6 inches for a 10-year storm, and 9 inches for a 100-year storm. The maximum depth of ponding at a flow control structure is 12 inches for a 100-year storm.
- The storage area (portion of the parking lot subject to ponding) must have a minimum slope of 0.5% towards the outlet to ensure complete drainage following a storm. A slope of 1% or greater is recommended.
- Fire lanes used for emergency equipment must be free of ponding water for runoff events up to the extreme storm (100-year) event.
- Flows are typically backed up in the parking lot using a raised inlet.

Rooftop Storage

- Rooftops can be used for detention storage as long as the roof support structure is designed to address the weight of ponded water and is sufficiently waterproofed to achieve a minimum service life of 30 years. All rooftop detention designs must meet Georgia State Building Code and Columbia County building code requirements.
- The minimum pitch of the roof area subject to ponding is 0.25 inches per foot.
- The rooftop storage system must include another mechanism for draining the ponding area in the event that the primary outlet is clogged.

Sports Fields

- Athletic facilities such as football and soccer fields and tracks can be used to provide stormwater detention. This is accomplished by constructing berms around the facilities, which in essence creates very large detention basins. Outflow can be controlled through the use of an overflow weir or other appropriate control structure. Proper grading must be performed to ensure complete drainage of the facility.

Public Plazas

- In high-density areas, recessed public common areas such as plazas and pavilions can be utilized for stormwater detention. These areas can be designed to flood no more than once or twice annually, and provide important open recreation space during the rest of the year.

3.4.2.3 Inspection and Maintenance Requirements

Activity	Schedule
• Remove debris from ponding area to minimize outlet clogging and improve aesthetics.	Annually and following significant storm events
• Remove sediment buildup. • Repair and revegetate eroded areas. • Perform structural repairs to inlet and outlets.	As needed based on inspection
• Perform additional maintenance activities specific to the type of facility.	As required

Table 3.4.2-1 Typical Maintenance Activities for Multi-Purpose Detention Areas
(Based on: Denver Urban Storm Drainage Manual, 1999)

3.4.3 Underground Detention

Description: Detention storage located in underground tanks or vaults designed to provide water quantity control through detention and/or extended detention of stormwater runoff.

REASONS FOR LIMITED USE

- Controls for stormwater quantity only – not intended to provide water quality treatment
- Intended for space-limited applications

KEY CONSIDERATIONS

- Does not take up surface space
- Used in conjunction with water quality structural control
- Concrete vaults or pipe/tank systems can be used

STORMWATER MANAGEMENT SUITABILITY

- ☐ **Water Quality**
- ☑ **Channel / Flood Protection**

SPECIAL APPLICATIONS

- ☐ **Pretreatment**
- ☑ **High Density / Ultra-Urban**
- ☐ **Other:**

Residential Subdivision Use: *No*

3.4.3.1 General Description

Detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are underground storage facilities typically constructed with large diameter metal or plastic pipe. Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for space-limited areas where there is not adequate land for a dry detention basin or multi-purpose detention area.

Both underground vaults and tanks can provide channel protection through extended detention of the channel protection volume (CP_v), and overbank flood Q_{p50} (and in some cases extreme flood Q_f) control through normal detention. Basic storage design and routing methods are the same as for detention basins except that the bypass for high flows is typically included.

Underground detention vaults and tanks are not intended for water quality treatment and must be used in a treatment train approach with other structural controls that provide treatment of the WQ_v (see Section 3.1). This will prevent the underground vault or tank from becoming clogged with trash or sediment and significantly reduces the maintenance requirements for an underground detention system.

Prefabricated concrete vaults are available for commercial vendors. In addition, several pipe manufacturers have developed packaged detention systems.

3.4.3.2 Design Criteria and Specifications

Location

- Underground detention systems are to be located downstream of other structural stormwater controls providing treatment of the water quality volume (WQ_v). See Section 3.1 for more information on the use of multiple structural controls in a treatment train.
- The maximum contributing drainage area to be served by a single underground detention vault or tank is 25 acres.

General Design

- Underground detention systems are sized to provide extended detention of the channel protection volume over 24 hours and temporarily store the volume of runoff required to provide overbank flood (Q_{p50}) protection (i.e., reduce the post-development peak flow of the 50-year storm event to the pre-development rate). Due to the storage volume required, underground detention vaults and tanks are typically not used to control the 100-year storm (Q_f) except for very small drainage areas (<1 acre).

  Routing calculations must be used to demonstrate that the storage volume is adequate. See Section 2.2 (*Storage Design*) for procedures on the design of detention storage.
- Detention Vaults: Minimum 3,000 psi structural reinforced concrete may be used for underground detention vaults. All construction joints must be provided with water stops. Cast-in-place wall sections must be designed as retaining walls. The maximum depth from finished grade to the vault invert should be 20 feet.
- Detention Tanks: The minimum pipe diameter for underground detention tanks is 36 inches.
- Underground detention vaults and tanks must meet structural requirements for overburden support and traffic loading if appropriate.
- Adequate maintenance access must be provided for all underground detention systems. Access must be provided over the inlet pipe and outflow structure. Access openings can consist of a standard frame, grate and solid cover, or a removable panel. Vaults with widths of 10 feet or less should have removable lids.

Inlet and Outlet Structures

- A separate sediment sump or vault chamber sized to 0.1 inches per impervious acre of contributing drainage should be provided at the inlet for underground detention systems that are in a treatment train with off-line water quality treatment structural controls.
- For CP_v control, a low flow orifice capable of releasing the channel protection volume over 24 hours must be provided. The channel protection orifice should have a minimum diameter of 3 inches and should be adequately protected from clogging by an acceptable external trash rack. The orifice diameter may be reduced to 1 inch if internal orifice protection is used (i.e., an over-perforated vertical stand pipe with 0.5-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves can also be used to achieve this equivalent diameter.

  For overbank flood protection, an additional outlet is sized for Q_{p50} control (based upon hydrologic routing calculations) and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure.

  See Section 2.3 *(Outlet Structures)* for more information on the design of outlet works.
- Riprap, plunge pools or pads, or other energy dissipators are to be placed at the end of the outlet to prevent scouring and erosion. See Section 4.5, Energy Dissipation Design, for more guidance.
- A high flow bypass is to be included in the underground detention system design to safely pass the extreme flood flow.

3.4.3.3 Inspection and Maintenance Requirements

Activity	Schedule
• Remove any trash / debris and sediment buildup in the underground vaults or tanks.	Annually and following significant storm events
• Perform structural repairs to inlet and outlets.	As needed based on inspection

Table 3.4.3-1 Typical Maintenance Activities for Underground Detention Systems

3.4.3.4 Example Schematics

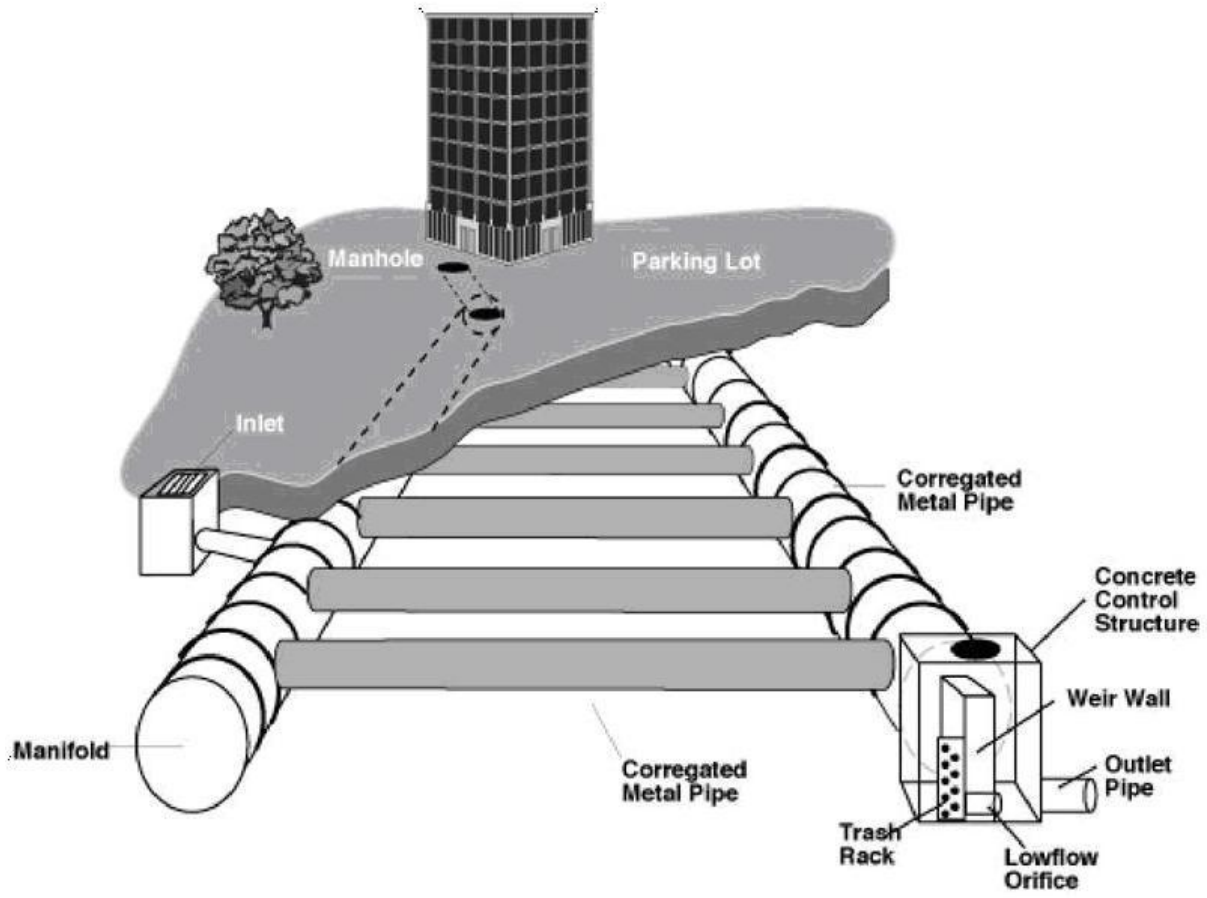

Figure 3.4.3-1 Example Underground Detention Tank System

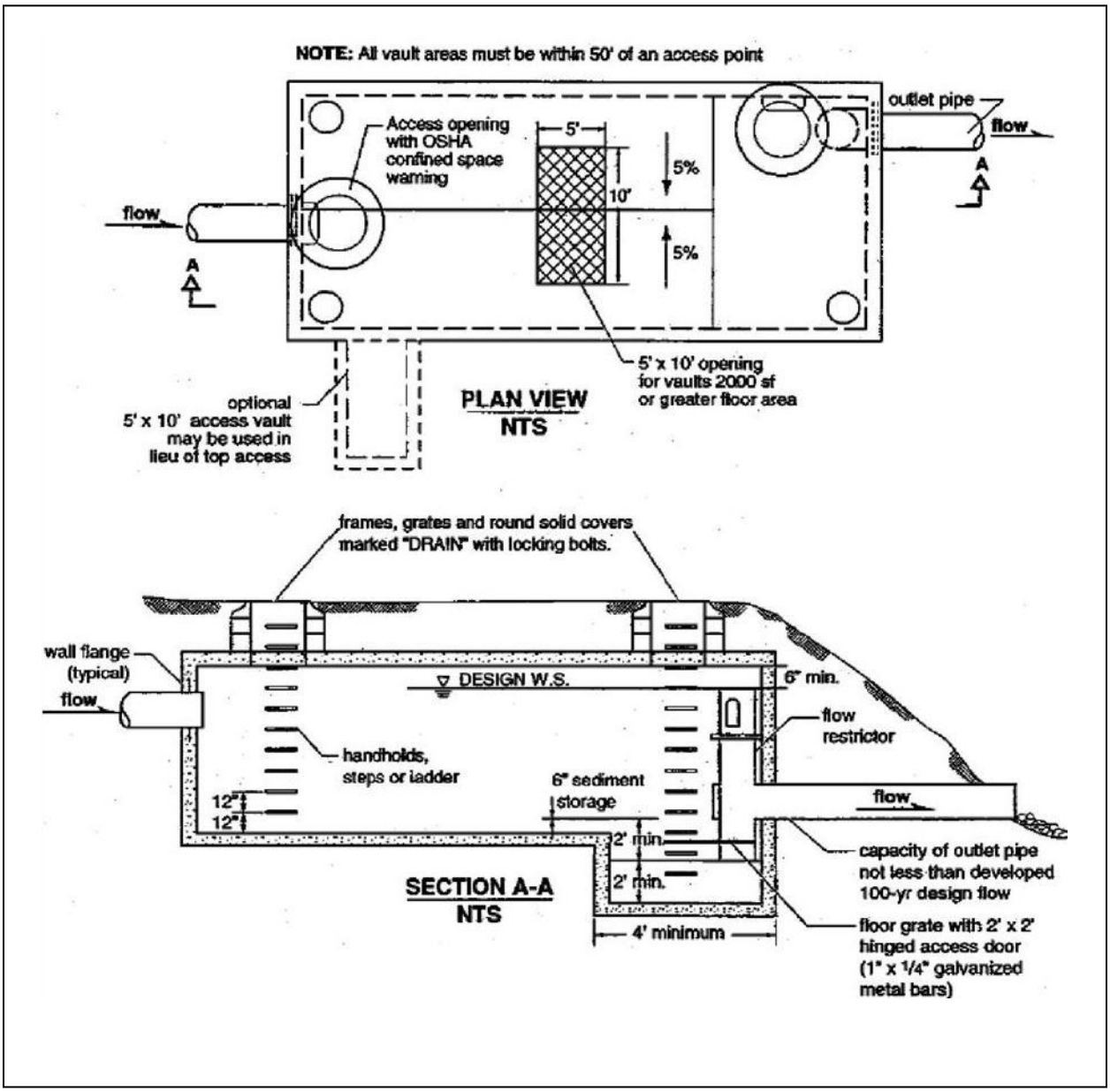

Figure 3.4.3-2 Schematic of Typical Underground Detention Vault
(Source: WDE, 2000)

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